TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371	ATTORNEY'S DOCKET NUMBER 19378.0010 U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/857974

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/SE99/02218	29 November 1999	14 December 1998

TITLE OF INVENTION
A METHOD OF AND A DEVICE FOR ACTIVELY REDUCING THE LEVEL OF A PRIMARY FIELD OF SOUND OR VIBRATION IN A SPACE

APPLICANT(S) FOR DO/EO/US
Siv Leth, William G. Halvorsen, Patrick Barney

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [x] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. § 371.
3. [x] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. [x] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. [x] A copy of the International Application as **published** (35 U.S.C. 371(c)(2))**WO 00/36590**
   a. [x] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. [x] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [x] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the Annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. Below concern other document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [x] A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter
16. [x] Other items or information:

PCT/ISA/210
PCT/IPEA/401
PCT/IPEA/409 with amended sheets of claims 1-12 for prosecution
PCT/RO/101

...LICATION NO (If known, see 37 CFR 1.5) 09/857974	INTERNATIONAL APPLICATION NO. PCT/SE99/02218	ATTORNEY'S DOCKET NUMBER 19378.0010

JC03 Rec'd PCT/PTO 13 JUN 2001

X The following fees are submitted:

	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO....**$860.00** International preliminary examination fee paid to USPTO (37 CFR 1.482) ....**$690.00** No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2))....**$760.00** Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO....**$1,000.00** International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4)....**$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$1,000.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 [x] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$ 130.00	

Claims	Number Filed	Number	Rate		
Total Claims	12 - 20 =	0	X **$18.00**	$	
Independent Claims	2 - 3 =	0	X **$80.00**	$	
Multiple dependent claim(s)(if applicable)			+ **$270.00**	$	
			TOTAL OF ABOVE CALCULATIONS =	**$1,130.00**	
Reduction by 1/2 for filing by small entity, if applicable.				$	
			SUBTOTAL =	**$1,130.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				$	
			TOTAL NATIONAL FEE =	**$1,130.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	
			TOTAL FEES ENCLOSED =	**$1,130.00**	
				Amount to be: Refunded	$
				Charged	**$1,130.00**

a. ☐ A check in the amount of $___ to cover the above fees is enclosed.

b. [x] Please charge my Deposit Account No. 19-5127; 19378.0010 in the amount of **$1,130.00** to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [x] The Director is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 19-5127. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b) must be filed and granted to restore the application to pending status

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REGISTRATION NUMBER

09/857974
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Atty Docket: 19378.0010

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:	:	
	:	
Siv Leth et al.	:	
	:	
Application No.: -- U.S. National Phase of PCT/SE99/02218	:	Examiner: --
	:	
Filed: June 13, 2001	:	Art Unit --

Title: A METHOD AND A DEVICE FOR ACTIVELY REDUCING THE LEVEL OF A PRIMARY FIELD OF SOUND OR VIBRATION IN A SPACE

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

Prior to examination, please amend the above-identification as follows:

In the Claims:

Please amend the claims as follows:

Clean Copy of Amended Claims

4. A method according to claim 1, characterized by producing said force vector (F) by the multiplication of the pseudo inverse of the first transfer matrix (3), said first projection matrix (j), the pseudo inverse of the said second projection matrix (o), and said residual vector (b).

5. A method according to claim 1, characterized by reducing the number of control sensors (7) included in the first projection matrix (j) and the second projection matrix (o) to include only an optimal set of control sensors (7) for projecting each monitor sensor (16).

6. A method according claim 1, characterized in that the parameter comprises a pressure.

7. A method according to claim 1, characterized in that the parameter comprises a vibration.

11. A device according to claim 8, characterized in that said control unit (10, 12) is arranged to produce said force vector (F) by the multiplication of the pseudo inverse of the first transfer matrix (e), said first projection matrix (j), the pseudo inverse of the said second projection matrix (c), and said residual vector (b).

12. A device according to claim 8, characterized in that said control unit (10, 12) is arranged to reduce the number of control sensors (7) included in the first projection matrix (j) and the second projection matrix (c) to include only an optimal set of control sensors (7) for projecting each monitor sensor (16).

Claim Amendments

4. (Amended) A method according to [any one of the preceding claims] claim 1, characterized by producing said force vector (F) by the multiplication of the pseudo inverse of the first transfer matrix (3), said first projection matrix (j), the pseudo inverse of the said second projection matrix (o), and said residual vector (b).

5. (Amended) A method according to [any one of the preceding claims] claim 1, characterized by reducing the number of control sensors (7) included in the first projection matrix (j) and the second projection matrix (o) to include only an optimal set of control sensors (7) for projecting each monitor sensor (16).

6. (Amended) A method according [any one of the preceding claims] claim 1, characterized in that the parameter comprises a pressure.

7. (Amended) A method according to [any one of the preceding claims] claim 1, characterized in that the parameter comprises a vibration.

11. (Amended) A device according to [any one claims 8 to 10] claim 8, characterized in that said control unit (10, 12) is arranged to produce said force vector (F) by the multiplication of the pseudo inverse of the first transfer matrix (e), said first projection matrix (j), the pseudo inverse of the said second projection matrix (c), and said residual vector (b).

12. (Amended) A device according to [any one of the claims 8 to 11] claim 8, characterized in that said control unit (10, 12) is arranged to reduce the number of control sensors (7) included in the first projection matrix (j) and the second projection matrix (c) to include only an optimal set of control sensors (7) for projecting each monitor sensor (16).

Remarks

Applicants have amended the claims to eliminate multiple dependencies.

Respectfully submitted,

Date: June 13, 2001

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A METHOD OF AND A DEVICE FOR ACTIVELY REDUCING THE LEVEL OF A PRIMARY FIELD OF SOUND OR VIBRATION ~~IN A SPACE~~

THE BACKGROUND OF THE INVENTION AND PRIOR ART

The present invention refers to a method of actively reducing the level of a primary field of sound or vibration in a space, comprising the steps of: providing a first number of actuators in the space to produce a secondary field of sound or vibration, which is adapted to interfere with the primary field; providing a second number of control sensors in the space to sense a parameter related to the residual level of the primary field and the secondary field; and determining a first transfer matrix defining for each control sensor the level of the parameter caused by a certain level of the excitation from each actuator.

Moreover, the present invention refers to a device for actively reducing the level of a primary field of sound or vibration in a space, comprising a first number of control sensors provided in the space to sense a parameter related to the residual level of the primary field and the secondary field; a second number of actuators provided in the space to produce a secondary field of sound or vibration, which is adapted to interfere with the primary field; and a first determining means provided to determine a first transfer function matrix defining for each control sensor the level of the parameter caused by a certain level of the excitation from each actuator.

It is known to reduce the level of a primary field of noise in a space by means of a set of actuators provided to

produce a secondary field of sound to interfere with the primary field. Thereby, a set of control sensors is provided in the space at the locations where a maximum reduction is desired. A control unit provides such a force at each actuator that the sound level at the control sensors is reduced to a minimum level.

Such a known noise reduction method is effective to reduce the noise at the location of the control sensors, whereas the noise level in the space at positions removed from the control sensors is not directly controllable by the method. In addition, the noise level at positions removed from the control sensors may be significant, and at certain locations the secondary field may, instead of reducing the primary field, interfere in such a way that the total level of the combined fields is higher than the level of the primary field alone. By the known method, it is thus necessary to position the control sensors immediately adjacent to the locations at which an essential noise reduction is desirable. For several reasons, such a positioning of the control sensors is not possible.

US-A-5 381 485 discloses a device for actively reducing the sound or noise level in a specific region of a space. The device of this document comprises a loudspeaker which is intended to generate sound waves to interfere with unwanted sound waves and thereby produce a region having a substantially reduced sound level. Furthermore, a control microphone, located closer to the loudspeaker than the region, is provided to sense the sound in the space. A loudspeaker control means has an input connected to the control microphone and an output connected to the loudspeaker for operating the latter. The loudspeaker control means comprises a signal processing means arranged to simulate a virtual microphone signal that would have been obtained if the microphone were to be positioned in said

region, i.e. where it is desired to reduce the sound level. The simulated signal is used to control the loudspeaker. However, the technique presented in this document in reality merely appears to be applicable to one microphone and one loudspeaker. Furthermore, the known solution may only be employed when the control microphone and the virtual microphone are located at a relatively small distance from each other in relation to the acoustic wave length, i.e. significantly shorter than the acoustic wave length.

SUMMARY OF THE INVENTION

The object of the present invention is to provide an improved reduction of the noise and/or vibration level in a space. In particular, it is aimed at a reduction of the noise and/or vibration level at an arbitrary position in a space.

This object is obtained by the method initially defined and characterized by providing, during an initial, provisional period of time, a third number of monitor sensors in the space to sense the parameter related to the level of the primary field, determining a second transfer matrix defining for each monitor sensor the level of the parameter caused by a certain level from each actuator, and controlling the actuators by means of a force vector being a function of the first transfer matrix, a first projection matrix reflecting the relation between the first transfer matrix and said second transfer matrix, a second projection matrix reflecting the relations between the parameter sensed by the control sensors and the parameter sensed by said monitor sensors, and a residual vector of the actual level of the parameter at the control sensors.

By such a method it is possible to provide an arbitrary number of actuators, control sensors and monitor sensors,

and thereby take into account the complexity of the fields in such a manner that a significant reduction of the noise or vibration level is obtained in the space at the location of the monitor sensors, which may be located in a position where it is not practically possible to provide control sensors, for instance at the location of a passenger in an aircraft cabin. According to the method of the invention, the control sensors are projected to the monitor sensors.

According to an embodiment of the present invention, said monitor sensors are provided at a respective position at which a significant reduction of the level of the primary field is desired. Thereby, the control sensors may be provided at a distance from the positions of said monitor sensors.

According to a further embodiment of the present invention, said force vector is advantageously produced by a multiplication of the pseudo inverse of the first transfer matrix, said first projection matrix, the pseudo inverse of said second projection matrix, and said residual vector. Consequently, an effective control function for controlling the forces to be applied to the actuators may be achieved by simple matrix multiplication, which may be performed by conventional computer means.

According to a further embodiment of the present invention, the number of control sensors is reduced in the first projection matrix and the second projection matrix to include only an optimal set of sensors for projecting each monitor sensor. In such a manner, it is possible to improve the projection of the control sensors to the monitor sensors by using only the most significant control sensors.

The object is also obtained by the device initially defined and characterized by a third number of monitor sensors

arranged to be provided in the space during an initial, provisional period of time to sense the parameter related to the level of the primary field, second determining means provided to determine a second transfer matrix defining for each monitor sensor the level of the parameter caused by a certain level of the excitation from each actuator, and a control unit provided to control the actuators by means of a force vector being a function of the first transfer matrix, a first projection matrix reflecting the relation between the first transfer matrix and said second transfer matrix, a second projection matrix reflecting the relations between the parameter sensed by the control sensors and the parameter sensed by said monitor sensors, and a residual vector of the actual level of the parameter at the control sensors.

Preferred embodiments of the device are defined in the dependent claims 9 - 12.

BRIEF DESCRIPTION OF THE DRAWING

The present invention is now to be described more closely by means of a preferred embodiment, merely disclosed by way of example, and with reference to the drawing attached hereto, in which Fig 1 shows a schematic cross-sectional view of an aircraft cabin having a device according to the invention for reducing the noise level.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE PRESENT INVENTION

Fig 1 discloses a cross-section through an aircraft body 1, comprising an inner space in the form of a conventional passenger cabin 2. The passenger cabin 2 is delimited by an inner wall 3 and a floor 4. In the passenger cabin 2, there are provided a plurality of seat rows merely one of which is

disclosed in Fig 1. Each seat row comprises four seats 5. During flight, a primary field of sound or noise in the passenger cabin 2 is produced by the operation of the aircraft.

According to the present invention, a device is provided in the passenger cabin 2 in order to reduce the level of the primary field. The device comprises a number of actuators 6 which are distributed along the inner wall 3 and the floor 4. In the embodiment disclosed the actuators 6 are realized as loudspeakers arranged to produce a secondary field of sound. The secondary field is adapted to interfere with said primary field. Furthermore, the device comprises a number of control sensors 7 which are distributed along the inner wall 3 and the floor 4. In the embodiment disclosed, the control sensors 7 are realized as microphones arranged to sense the residual level of the pressure caused by the primary field and the secondary field.

Each actuator 6 and each control sensor 7 is connected via a conduit 8 and 9, respectively, to a control unit 10. The control unit 10 may comprise an input member 11, provided to receive signals from the control sensors 7 and to convert the signals to a suitable digital form; a computerized processing member 12, provided to process said converted signals; and an output member 13, provided to convert the processed signals to a suitable form and to transmit these signals to a respective actuator 6. Furthermore, said control unit 10 comprises a memory member 14 including a memory of the type RAM and connected to the processing member 12.

In the embodiment disclosed, four regions 15 have been indicated, in which the ears of the passengers present in the passenger cabin 2 normally are located during flight. Thus, it is particularly important to reduce the noise level

in these regions 15. A number of monitor sensors 16, in the form of monitor microphones, is arranged in the regions 15 during an initial preparing period before the device is employed for noise reduction. It is to be noted that the monitor sensors 16 may be removed from the passenger cabin 2 after the performance of such measurements and during operation of the device. The provisionally provided monitor sensors 16 are also connected to the control unit 10 during said preparing period and arranged to sense the pressure level caused by a certain force applied to the actuators 6. During this preparing or measurement period the level of the primary field is essentially equal to zero.

The numbers of control sensors 7, actuators 6 and monitor sensors 16 may vary depending on the actual conditions, for instance the size and the complexity of the passenger cabin 2. Although not a requirement, in the embodiment disclosed the number of control sensors 7 is higher than the number of actuators 6. According to an example, the number of actuators 6 may be 36, the number of control sensors 7 may be 72, and the number of monitor sensors 16 may be 70.

As an example of a simple and commonly used control strategy, the forces, found by using the LMS algorithm, can be written and will be used:

$$\mathbf{F}_{i+1} = \mathbf{F}_i - \mathbf{H}_c^{+} \mathbf{E}_{ci} \qquad \text{(a)}$$

where i is an index indicating the time step in the update of the equation in the controller and

$\mathbf{E}_c$ is a residual vector of the actual level of the pressure at each control sensor 7, (b)

$\mathbf{H}_c$ is a first matrix defining the transfer function from each actuator 6 to each control sensor 7, (c)

$\mathbf{F}$ is a force vector defining the forces to be (d)

applied to each actuator 6, and

$\mathbf{H}_c^+$ is an pseudo inverse of the first transfer function matrix $\mathbf{H}_c$. (e)

Consequently, the control function (a), in the embodiment disclosed, is realized by the LMS-algorithm (Least Mean Square). Moreover, other types of the LMS-algorithms may be employed, for instance a so called leaky LMS-algorithm. Within the scope of the present invention also other algorithms may be employed, for instance a RLS-algorithm (Recursive Least Square).

However, since it is desirable to obtain a maximal reduction of the noise level in the regions 15, it would be desirable to control the actuators 6 by a signal sensed by a monitor sensor 16, i.e. according to the control function

$$\mathbf{F}_{i+1} = \mathbf{F}_i - \mathbf{H}_m^+ \mathbf{E}_{mi} \qquad \text{(f)}$$

where

$\mathbf{H}_m$ is a second matrix defining the transfer function from each actuator 6 to each monitor sensor 16, (g)

$\mathbf{H}_m^+$ is the pseudo inverse of the second transfer function matrix $\mathbf{H}_m$, and (h)

$\mathbf{E}_m$ is a residual vector of the actual level of the pressure at each monitor sensor 16. (i)

As indicated above, the monitor sensors 16 are not employed during flight and therefore the matrix $\mathbf{H}_m$ is determined in advance by means of the processing member 12 of the control unit 10 during the above-identified preparing period and is stored in the memory member 14.

It is assumed that a projection matrix $\mathbf{P}_H$ may be set up as

$$\mathbf{P_H} = \mathbf{H_c}\ \mathbf{H_m}^+ \quad \text{(j)}$$

where

$\mathbf{P_H}$ is a first projection matrix reflecting the relation between the transfer matrix $\mathbf{H_c}$ and the transfer matrix $\mathbf{H_m}$.

Furthermore, it is assumed that a projection matrix $\mathbf{P_U}$ may be set up where

$$\mathbf{U_c} = \mathbf{P_U}\ \mathbf{U_m}$$

where

$\mathbf{P_U}$ is a second projection matrix reflecting the relation between the pressure level at each control sensor 7 and the pressure level at each monitor sensor 16 due to the primary field, (k)

$\mathbf{U_c}$ is a vector of the actual level of the pressure at each control sensor 7 due to the primary field, and (l)

$\mathbf{U_m}$ is a vector of the actual level of the pressure actual level of the pressure at each monitor sensor 16 due to the primary field. (m)

Consequently, the residual force may hence be defined by the control function

$$\mathbf{F_{i+1}} = \mathbf{F_i} - \mathbf{H_c}^+\ (\mathbf{P_H}\ \mathbf{P_U}^+)\ \mathbf{E_{ci}} \quad \text{(n)}$$

where

$\mathbf{P_U}^+$ is the pseudo inverse of the second projection matrix $\mathbf{P_U}$. (o)

Also $\mathbf{P_H}$ and $\mathbf{P_U}^+$ may be calculated by the processing member 12 and stored in the memory member 14.

Consequently, the noise reduction according to the control function (n) takes into account the fact that the control sensors 7 are not located in the regions 15 where a maximum noise reduction is desired.

The device according to the invention permits a large number of control sensors and monitor sensors 16 to be utilized, and thus it is possible to effectively reduce the noise at an arbitrary location within the space 2 defined.

The determination of the first projection matrix (j) for the control function (n) is an error minimization of the predicted response compared to the actual response of the monitor sensors 16. Initially, the first projection matrix $\mathbf{P_H}$ as defined takes into account all control sensors 7. In a subsequent operation, an optimal set of control sensors 7 is obtained for projecting each monitor sensor 16. Thereby, it is possible to reduce the number of control sensors 7 to include only the best control sensors 7 in the control function (n).

Furthermore, the full set of control sensors 7 in the second projection matrix $\mathbf{P_U}$ is reduced to include only the most significant control sensors 7 in the pseudo inverse of the first projection matrix $\mathbf{P_H}$ for a given monitor sensor 16. The selected control sensors are used in (k) and an iterative process is used to populate the second projection matrix $\mathbf{P_U}$.

During operation of the device according to the invention, the control function (n) is continuously updated according to an appropriate iteration algorithm, at least with regard to the residual vector $\mathbf{E_C}$ and potentially with regard to the

transfer matrix $\mathbf{H}_C$. This means that an actual level of the force vector F is continuously calculated and applied to the actuators 6.

The control function (n) described above is defined for calculations in a frequency plane, which means that a control function (n) is utilized for each frequency to be reduced. It is to be noted that the invention may also be applied to a control function in a time plane. In an example for noise reduction in an aircraft, it is considered appropriate to reduce three different frequencies or frequency intervals.

The present invention is not limited to the embodiment described herein but may be varied and modified within the scope of the following claims.

Although the embodiment disclosed refers to the reduction of sound or noise, it is to be noted that the invention is applicable to the reduction of vibrations as well. In this case the control sensors 7 may be arranged to sense a vibration, and the actuators may comprise shakers.

Although the device and the method according to the invention have been described in connection with noise reduction in aircraft, it is to be noted that the invention is also applicable to other spaces, rooms in houses or buildings, passenger cabins in vehicles, such as cars, etc.

Claims

1. A method of actively reducing the level of a primary field of sound or vibrations in a space (2), comprising the steps of:
providing a first number of actuators (6) in the space (2) to produce a secondary field of sound or vibration, which is adapted to interfere with the primary field;
providing a second number of control sensors (7) in the space (2) to sense a parameter related to the residual level of the primary field and the secondary field; and
determining a first transfer matrix (c) defining for each control sensor (7) the level of the parameter caused by a certain level of excitation from each actuator (6),
characterized by
providing, during an initial, provisional period of time, a third number of monitor sensors (16) in the space (2) to sense the parameter related to the level of the primary field;
determining a second transfer matrix (g) defining for each monitor sensor (16) the level of the parameter caused by a certain level from each actuator (6); and
controlling the actuators (6) by means of a force vector (F) being a function (n) of the first transfer matrix (c), a first projection matrix (j) reflecting the relation between the first transfer matrix (c) and said second transfer matrix (g), a second projection matrix (k) reflecting the relations between the parameter sensed by the control sensors (7) and the parameter sensed by said monitor sensors (16), and a residual vector (b) of the actual level of the parameter at the control sensors (7).

2. A method according to claim 1, characterized by providing said monitor sensors (16) at respective positions (15) at which a significant reduction of the level of the primary field is desired.

3. A method according to claim 2, characterized by providing the control sensors (7) at locations at a distance from the positions (15) of said monitor sensors (16).

4. A method according to any one of the preceding claims, characterized by producing said force vector (F) by the multiplication of the pseudo inverse of the first transfer matrix (e), said first projection matrix (j), the pseudo inverse of the said second projection matrix (o), and said residual vector (b).

5. A method according to any one of the preceding claims, characterized by reducing the number of control sensors (7) included in the first projection matrix (j) and the second projection matrix (o) to include only an optimal set of control sensors (7) for projecting each monitor sensor (16).

6. A method according any one of the preceding claims, characterized in that the parameter comprises a pressure.

7. A method according to any one of the preceding claims, characterized in that the parameter comprises a vibration.

8. A device for actively reducing the level of a primary field of sound or vibration in a space (2), comprising
a first number of control sensors (7) provided in the space (2) to sense a parameter related to the residual level of the primary field and the secondary field;
a second number of actuators (6) provided in the space (2) to produce a secondary field of sound or vibrations, which is adapted to interfere with the primary field;
a first determining means provided to determine a first transfer function matrix (c) defining for each control sensor (7) the level of the parameter caused by a certain level of the excitation from each actuator (6),

characterized by
a third number of monitor sensors (16) arranged to be provided in said space (2) during an initial, provisional period of time to sense the parameter related to the level of the primary field;
a second determining means provided to determine a second transfer matrix (g) defining for each monitor sensor (16) the level of the parameter caused by a certain level from each actuator (6); and
a control unit provided to control the actuators (6) by means of a force vector (F) being a function (n) of the first transfer matrix (c), a first projection matrix (j) reflecting the relation between the first transfer matrix (c) and said second transfer matrix (g), a second projection matrix (k) reflecting the relations between the parameter sensed by the control sensors (7) and the parameter sensed by said monitor sensors (16), and a residual vector (b) of the actual level of the parameter at the control sensors (7).

9. A device according to claim 8, characterized in that said monitor sensors (16) are provided to be arranged during a preparing period of time at respective positions (15) at which a significant reduction of the level of the primary field is desired.

10. A device according to claim 9, characterized in that the control sensors (7) are provided at positions at a distance from the positions (15) of said monitor sensors (16).

11. A device according to any one claims 8 to 10, characterized in that said control unit (10, 12) is arranged to produce said force vector (F) by the multiplication of the pseudo inverse of the first transfer matrix (e), said

first projection matrix (j), the pseudo inverse of the said second projection matrix (o), and said residual vector (b).

12. A device according to any one of claims 8 to 11, characterized in that said control unit (10, 12) is arranged to reduce the number of control sensors (7) included in the first projection matrix (j) and the second projection matrix (o) to include only an optimal set of control sensors (7) for projecting each monitor sensor (16).

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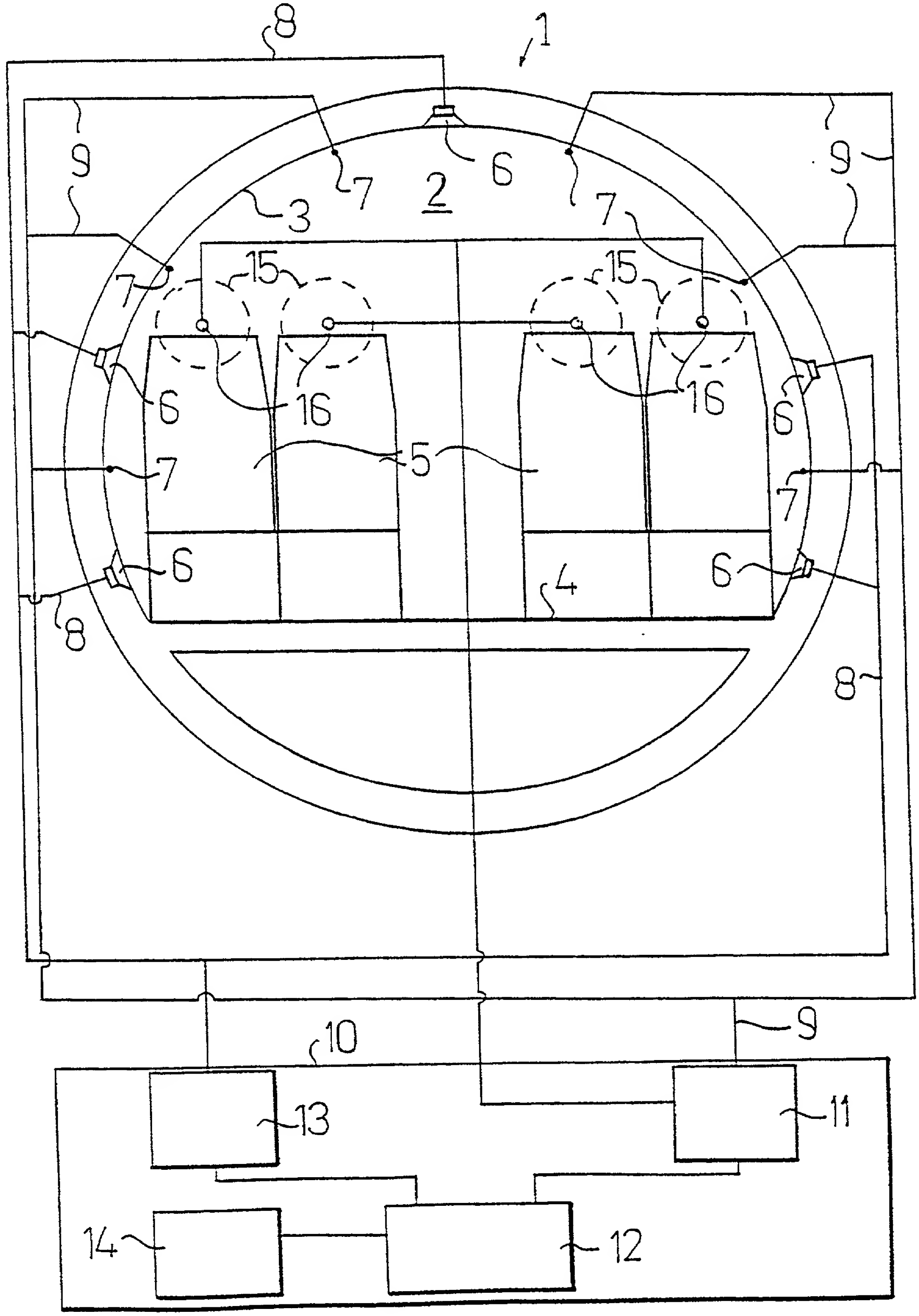
Fig 1

1/1



55268 UL

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (includes Reference to PCT International Applications)	Attorney's docket No

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

A METHOD OF AND A DEVICE FOR ACTIVELY REDUCING THE LEVEL OF A PRIMARY FIELD OF SOUND OR VIBRATION IN A SPACE
the specification of which (check only one item below):

[ ] is attached hereto.

[ ] was filed as United States application.
Serial No. ______
on ______
and was amended
on ______ (if applicable).

[X] was filed as PCT international application
Number PCT/SE99/02218
on 29 November, 1999
and was amended under PCT Article 19
on ______ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (if PCT indicate PCT)	APPLICATION NO.	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 U.S.C. 119
Sweden	9804311-0	14 December 1998	[x] YES [ ] NO
			[ ] YES [ ] NO
			[ ] YES [ ] NO

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

55268

Combined declaration for patent application and power of attorney (continued) (includes Reference to PCT International Applications)	Attorney's docket No.

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120:

U.S. APPLICATIONS		STATUS (Check one)		
APPLICATION NO.	U.S. FILING DATE	PATENTED	PENDING	ABANDONED

PCT APPLICATIONS DESIGNATING THE U.S.					
APPLICATION NO.	FILING DATE	US SERIAL NO. ASSIGNED (if any)			
PCT/SE99/02218	29 November 1999				

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration number):
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true: and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
Siv Leth	William Halvorsen	Patrick Barney
DATE 15 June 2001	DATE 6 June 2001	DATE June 1, 2001